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⑭発明の名称　木質床材及びその製造方法

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明細書

1．発明の名称

木質床材及びその製造方法。

2．特許請求の範囲

1）上面に塗料が塗布されてなる木質床材において、該塗料中にケイ皮アルデヒド、クマリン、シトロネラールから選択される少なくとも1種の高沸点成分並びにテルペン類又はセスキテルペン類を主成分とする天然精油が含有されていることを特徴とする木質床材。

2）ケイ皮アルデヒド、クマリン、シトロネラールから選択される少なくとも1種の高沸点成分とテルペン類又はセスキテルペン類を主成分とする天然精油とを塗料用希釈剤に添加し、次いで塗料と混合した後木質床材に塗布することを特徴とする木質床材の製造方法。

3）テルペン類又はセスキテルペン類を主成分とする天然精油とケイ皮アルデヒド、クマリン、シトロネラールから選択される少なくとも1種の高沸点成分の混合比率が100：10～15の範囲内である請求項2に記載の木質床材の製造方法。

3．発明の詳細な説明

《産業上の利用分野》

本発明は、木質床材及びその製造方法に関し、更に詳しくはいわゆる森林浴効果、衛生害虫の忌避効果を有する木質床材及びその製造方法に関する。

《従来の技術》

樹木が発散するテルペン類又はセスキテルペン類を主成分とする天然精油が人体に森林浴の効果を与え、更にダニ、ゴキブリ等の衛生害虫を忌避させる効果を有することが知られるようになってから、これらの天然精油は芳香剤や防虫剤としてのみならず、様々な分野で採用されるようになった。

特に畳やカーペットにおけるダニ類の発生が社会問題となっている今日、これらの天然精油を含有せしめた木質床材への期待度は大きい。

このような状況の中で、最近、化粧単板と合板

との間の接着剤層にエマルジョン化した天然精油を含有せしめた木質床材が提案された。

しかしながら、上記の木質床材においては、接着剤層、化粧単板及び塗膜をそれぞれ通過した後に初めて天然精油が大気中に発散される。従って、例えば、合成樹脂を含浸強化した木質化粧単板を上面に貼着せしめた木質床材や上面にポリエステル塗料を厚塗りした木質床材の場合には、天然精油が表面層を通過することができないため天然精油の効果を得ることができないという欠点を有していた。

《発明が解決しようとする課題》

本発明者等は、上記の欠点を解決すべく鋭意検討を重ねた結果、①天然精油は本来蒸発し難い物質であり長期にわたって香りが持続すること、②木材中に含有されているケイ皮アルデヒド、クマリン、シトロネラール等の特に高沸点成分は（以下ケイ皮アルデヒド等とする）は徐放性に優れ、ダニ、ゴキブリ等の衛生害虫を忌避させる効果が高いこと及び③天然精油及びこれらの高沸点成分は塗料に用いるシンナーとの相溶性が良いこと等に着目し、天然精油にケイ皮アルデヒド等の高沸点成分を混合し、これを塗料に含有せしめて木質床材の上面に塗工することにより、どのようなタイプの木質床材に対しても、いわゆる森林浴効果や衛生害虫の忌避効果等を容易且つ長期にわたり付与せしめることができることを見出し本発明に到達した。

従って本発明の第１の目的は、木質床材を構成する素材の種類に依らず、長期にわたって森林浴効果や衛生害虫の忌避効果を発揮することのできる木質床材を提供することにある。

本発明の第２の目的は、どのようなタイプの木質床材に対しても適用することができる、森林浴効果や衛生害虫の忌避効果等を有する木質床材の製造方法を提供することにある。

本発明の第３の目的は、森林浴効果のみならず、特に衛生害虫の忌避効果にも優れた木質床材の製造方法を提供することにある。

《課題を解決するための手段》

本発明の上記の諸目的は、上面に塗料が塗布されてなる木質床材において、該塗料中にケイ皮アルデヒド、クマリン及びシトロネラールから選択される少なくとも１種の高沸点成分並びにテルペン類又はセスキテルペン類を主成分とする天然精油が含有されていることを特徴とする木質床材、及びその製造方法によって達成された。

以下、本発明の天然精油含有木質床材及びその製造方法を詳述する。

本発明において使用する天然精油は、檜葉油、檜材油、中国産トドマツ、ソ連産トドマツ、ユーカリ、杉、ヒバ、レモン、オレンジ、ラベンダー等のテルペン類又はセスキテルペン類を主成分とする公知の原料の中から適宜選択して使用することができるが、天然精油の効果を長期にわたって持続せしめる観点から檜葉油、檜材油、中国産トドマツ、ソ連産トドマツ、ユーカリ、杉、ヒバ、ラベンダー等の天然精油を使用することが好ましい。

本発明においては上記天然精油に加えて更に、ケイ皮アルデヒド、クマリン及びシトロネラールの中から選択される少なくとも１種の高沸点成分を使用する。

本発明において高沸点成分として使用するケイ皮アルデヒド、クマリン及びシトロネラール等は、衛生害虫の忌避効果の高い木材抽出成分であり、これ等を加えることにより極めて長期にわたって衛生害虫の忌避効果を維持させることができる。

ここで、ケイ皮アルデヒド等をテルペン類又はセスキテルペン類等を主成分とする天然精油１００重量部に対して１０重量部以下とすると生物効果が低減し、逆に１０重量部以上とすると気中濃度及び生物効果は高くなるが匂いが強くなり香り効果の点でマイナスになる。従って、前記した天然精油と高沸点成分であるケイ皮アルデヒド等の混合比率は、香り、徐放性、生物効果等を考慮して１００：１０～１５（重量比）とすることが好ましい。

本発明においては、上記の天然精油及びケイ皮アルデヒド等の高沸点成分を酢酸エチル等の希釈

剤で濃度５０％まで希釈した後塗料用シンナーと混合する。

次に、上記希釈液を塗料主剤に添加し、更に硬化剤及びシンナーを加えて塗料の粘度を調節する。上記希釈液の使用量は、塗料主剤１００重量部に対して１～２重量部というわずかな量で十分である。

以上の如くして得られた塗料を木質床材の上面に塗工して本発明の木質床材を得る。

通常、塗工は３回塗りで行われるが、本発明で使用する塗料は一般の塗料と何ら変わるものではないので、通常の方法によって塗工を行うことができる。必要に応じ、一般の塗料と交互に塗布することにより、ケイ皮アルデヒド等の大気中への徐放性、生物効果等にバリエーションを持たせることもできる。

尚、本発明の製造方法で得られる塗料は、木質床材に限らず内装用壁材や家具等、他の用途にも使用することができることは当然である。

《発明の効果》

以上詳述した如く、本発明の木質床材の製造方法はどのようなタイプの木質床材にも適用することができ、使用する材料によって限定されることがない。

又、本発明の方法で製造された木質床材は、テルペン類、セスキテルペン類等を主成分とする天然精油のみならず、ケイ皮アルデヒド、クマリン、シトロネラールの中から選択された一種以上の高沸点成分を含有するため森林浴効果のみならず、特に衛生害虫の忌避効果に優れ、長期にわたってその効果を持続することができる。

《実施例》

実施例１．

０．５㎜厚の絶乾状態（水分含有率０～３％）の桐スライス単板に不飽和ポリエステル樹脂１００重量部と重合開始剤１重量部の混合溶液を、含浸釜を用いて減圧加圧注入して樹脂含浸単板を得た。この樹脂含浸単板を、水性ビニルウレタン系接着剤を塗布した合板（１５g／尺^2 塗布量）に、ホットプレスを用いて１５０℃、１２kg／㎠、８分の条件で熱圧締することにより、単板内の樹脂の加熱重合を行わせると同時に樹脂含浸単板と合板を接着させ、合成樹脂含浸強化単板を表面に有する合板を得た。

次に、アミノ系塗料を主剤として、硬化剤、シンナーを１００：１０：X（重量比）の割合で混合し、上記樹脂硬化単板の上面に１．９～２．２g尺^2 の塗布量で下塗りし次いで乾燥せしめた後、下塗りに使用したものと同じ塗料を１．５～２．０g／尺^2 の塗布量で中塗りして乾燥した。シンナーの添加量（X）はイワタ式カップで塗料粘度が１２～１５sec．になるように調節した。

次に、シンナー、ヒノキ精油及びケイ皮アルデヒドを５０：４５：５（重量比）の比率で混合し、塗料主剤、上記の天然精油混合溶液、硬化剤及びシンナーを１００：１：１０：Y（重量比）で混合して、６．５～７．０g／尺^2 の塗布量で上塗りした。シンナーの添加量（Y）は、イワタ式カップで塗料粘度が１２～１５sec．になるように調節した。

上記の如くして得られた木質床材と一般の木質床材を用いて、ダニ、カビ、ゴキブリに対する生物効果試験を行った。

各生物効果抑制試験方法と結果は以下の通りである。

〔ダニ増殖抑制試験〕

４×４㎝に切断した本発明の木質床材と一般の木質床材を、各々直径９㎝の滅菌シャーレ中に塗装面が上面になるように置き、この上にコナヒョウヒダニを培養した培地（粉末飼料：ラット用飼料＋ドライイースト）約０．５gを３×３㎝に広げた。培地中のダニ数は約１００匹であった。

このシャーレ内部を飽和塩化カリウム溶液で約８６％に調湿し、２５～３０℃の温度下に保存した。

試験開始から１日、９日及び２０日後に、実体顕微鏡下で培地中の生存ダニ数をカウントして各床材のダニ生存率を求めた。ダニ生存率は、試験開始後の生存ダニ数を試験開始時の生存ダニ数で割って、１００を掛けた値である。その結果を表

1図に示す。図中、●は本発明の木質床材であり、○は一般の木質床材である（以下、第2図及び第3図において同じ）。

〔カビ抵抗性試験〕

JIS Z 2911（1981）「カビ抵抗性試験方法」 一般工業製品、木竹製品の試験法に準じて試験を行った。

Aspergillus niger IFO 6341、Penicilium citrinum IFO 6352、Rhizopus stolonifer FERM S-7、Cladosporium cladosporioides IFO 6348及びChaetomium globosum IFO 6347の5種類の各菌株をポテトデキストロース寒天斜面培地を用いて温度が25℃の雰囲気下で10日間培養した後、それぞれ滅菌した0.05%スルホコハク酸ジオクチルナトリウム水溶液に胞子を浮遊させ、単一胞子懸濁液を得た。次に、各胞子懸濁液を等量ずつ混合して混合胞子懸濁液を得た。

5×5cmにカットした本発明の木質床材と一般の木質床材（各床材は2連で実施）の試験片をシャーレ中に置き、その上から上記の混合胞子懸濁液を、見掛けの表面積9cm²に対して0.5mlの割合で均等にふりかけて蓋をし、温度28±2℃、湿度約97%で培養した。14日及び28日培養後に試験片の表面及び側面に生じた菌糸の発育状態を肉眼で観察した。

試験の結果を第1表に示す。

第1表

供試品	14日培養後		28日培養後	
	表面	側面	表面	側面
A）①	3	3	3	3
②	3	3	3	3
B）①	2	2	1	1
②	2	2	1	1

ここで、表中のA）は本発明の木質床材であり、B）は一般の木質床材である（以下、第2表～第6表も同様である）。尚、表中の数値は、下記の評価点を表す（以下、第3表及び第5表も同様である）。

3：試料または試験片の接種した部分に菌糸の発育が認められない。

2：試料または試験片の接種した部分に認められる菌糸の発育部分の面積は、全面積の1／3を越えない。

1：試料または試験片の接種した部分に認められる菌糸の発育部分の面積は、全面積の1／3を超える。

〔ゴキブリ忌避効果試験〕

合板で30×60×30cm（縦×横×高さ）のボックスを作製し、得られたボックスの真ん中を合板で仕切り、底部の一部にゴキブリ（クロゴキブリ）が通り抜けられる穴を開けた。仕切られた左右の空間の底部に本発明の木質床材と一般の木質化粧単板床材（各30×30cm）を敷き、各床材上に同数のゴキブリ（各10匹ずつ）を放ち、合板で作製した蓋をして25～30℃の雰囲気中に保存した。24時間保存した後蓋を取り、各床材上に存在しているゴキブリ数をカウントした。試験は3回繰り返して行った。ボックス及び床材は試験ごとに新しいものを使用し、天然精油やゴキブリの残臭による影響を避けた。尚、合板に残存しているホルマリンはホルマリンキャッチャー剤で除去した。試験開始後24時間の各床材上に存在しているゴキブリ数より、ゴキブリ存在率を求めた結果を第2表に示す。

ゴキブリ存在率は、各床材上の存在ゴキブリ数を全供試ゴキブリ数で割って、100を掛けた値である。

第2表

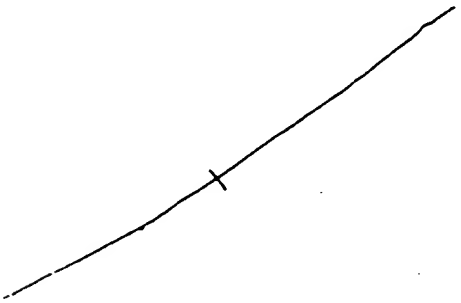
供試体	1回	2回	3回	計
A）存在数（匹）	1	0	1	2
存在率（%）	6	0	5	3
B）存在数（匹）	19	20	19	58
存在率（%）	95	100	95	97

以上の結果より、本発明の木質床材のダニ、カビ、ゴキブリに対する効果が証明された。この効果は、主としてケイ皮アルデヒド等の高沸点成分によるものと推定される。このように、塗料中にケイ皮アルデヒド等を僅かに添加するだけで高い生物効果が得られることが確認された。

実施例2.

シトロネーラールを使用した他は実施例1と同様にして木質床材を作製して、実施例1の場合と同様にダニ、カビ及びゴキブリに対する生物効果試験を行った。

第2図は、ダニ増殖抑制試験の結果、第3表はカビ抵抗性試験の結果及び第4表はゴキブリ忌避効果試験の結果である。



比較例1

ケイ皮アルデヒドを添加せず、ヒノキ精油のみを用いて、その他の製造方法は実施例1と全く同様の方法で木質床材を作製し、実施例1と同様の生物効果試験を行い、ケイ皮アルデヒドを添加した場合との効果の比較を行った。

第3図はダニ増殖抑制試験の結果、第5表はカビ抵抗性試験の結果及び第6表はゴキブリ忌避効果試験の結果である。

第5表

供試品	14日培養後		28日培養後	
	表面	側面	表面	側面
A) ①	3	3	2	2
②	3	3	3	3
B) ①	2	2	1	1
②	2	2	1	1

第3表

供試品	14日培養後		28日培養後	
	表面	側面	表面	側面
A) ①	3	3	3	3
②	3	3	3	3
B) ①	2	1	1	1
②	2	2	1	1

第4表

供試体	1回	2回	3回	計
A) 存在数(匹)	2	3	0	5
存在率(%)	10	15	0	8
B) 存在数(匹)	18	17	20	55
存在率(%)	90	85	100	92

第6表

供試体	1回	2回	3回	計
A) 存在数(匹)	5	5	7	17
存在率(%)	10	25	35	28
B) 存在数(匹)	15	15	13	43
存在率(%)	75	75	65	72

以上の結果より、テルペン類又はセスキテルペン類を主成分とする天然精油のみを含有させた場合でも衛生生物効果は生ずるものの、更にケイ皮アルデヒド等の高沸点成分を加えた場合の木質床材の衛生生物忌避効果が顕著に優れていることが証明された。

実施例3.

実施例1で得られた本発明の木質床材を8畳間大に施工する: 合を想定し、体積が8畳間の1／1000に相当する試験用ボックス中に8畳間の割合となるように本発明の木質床材を底面に置き、

ボックス内部の気中濃度を測定することによって推定した。

気中濃度の測定は、上記のボックス内に本発明の木質床材を一定時間置いたまま、テナックスＣＣ管に真空ポンプを装着して内部の空気を一定時間吸引し、充填剤に吸着した成分をＧＣ－ＭＳにて定量分析し、これらの吸着した成分比率と真空ポンプによる採気量から、テルペン類又はセスキテルペン類と高沸点成分の気中濃度を算出して行った。

以上の測定方法により、製造直後の本発明の木質床材を用いた場合の気中濃度は５～６ＰＰｂ（１ＰＰｍ／１０００）であった。又、製造１年後の木質床材を用いた場合の気中濃度は約１ＰＰｂであった。

以上の測定結果から、時間が経てば気中濃度は減少するものの徐放性は保たれることが実証された。

実施例４．

実施例１で得られた本発明の床材を用いて、製造直後、製造後１年経過後、製造後２年経過後の本発明の木質床材の表面を各々２０人による官能試験を行った結果、試験者によって程度の差はあるが、ほぼ下記のような結果を得た。

製造直後　　：香り一強

製造１年経過後　：香り一強くはないが感じられる。

製造２年経過後　：香り一若干感じられる。

以上の結果から、およそ数年レベルでは徐放性が十分に保たれることが推定された。

４．図面の簡単な説明

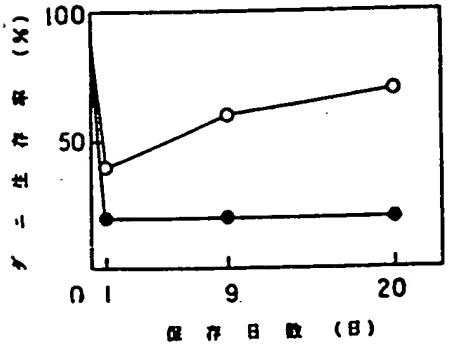
第１図は、実施例１におけるダニ増殖抑制試験の結果を示した図である。

第２図は実施例２における、ダニ増殖抑制試験の結果を示した図である。

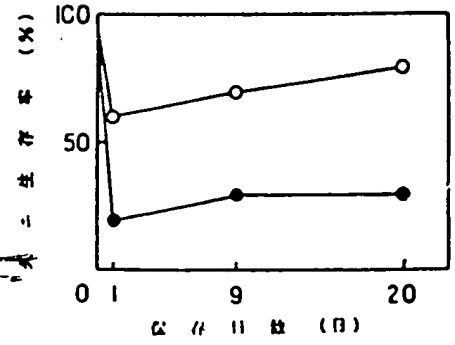
第３図は比較例１における、ダニ増殖抑制試験の結果を示した図である。

図中、●は本発明の木質床材であり、○は一般の木質床材である。

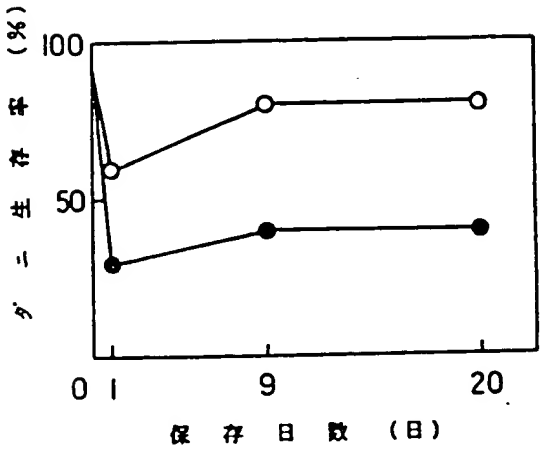
第　１　図



第　２　図



第　３　図



SPECIFICATION

1. Title of the Invention

Wood Flooring and Its Manufacturing Method

2. Scope of Patent Claims

- Claim 1

Wood flooring characterized in that the said wood flooring is covered with a paint that contains a natural essential oil with a terpene or a sequiterpene as the main constituent as well as at least one high-boiling-point constituent selected from among cinnamic aldehyde, coumarin, and citronellal.

- Claim 2

A wood flooring manufacturing method characterized in that a natural essential oil with a terpene or a sequiterpene as the main constituent as well as at least one high-boiling-point constituent selected from among cinnamic aldehyde, coumarin, and citronellal are added to the paint diluent, which is then mixed with the paint, after which the mixture is applied to a wood floor.

- Claim 3

The wood flooring manufacturing method described in Claim 2, characterized in that the mixture ratio is within the range 100:10-15, for the natural essential oil with a terpene or a sequiterpene as the main constituent as well as at least one high-boiling-point constituent selected from cinnamic aldehyde, coumarin, and citronellal.

3. Detailed Description of the Invention

• Field of Industrial Utilization

This invention concerns wood flooring and its manufacturing method. To be more specific, it concerns wood flooring with the so-called forest bath[1] effect and the vermin repellent effect, as well as its manufacturing method.

• Prior Art

Because it has become known that natural essential oils—which consist principally of the terpenes and sequiterpenes transpired by trees—provide humans with the forest bath effect and have the effect of repelling vermin such as ticks[2], cockroaches, etc., these natural essential oils have been utilized in various fields, not just as aromatics and insecticides[3].

Particularly now that the occurrence of ticks in *tatami* mats and carpets has become a social problem, there is great anticipation of wood flooring that contains these natural essential oils.

Under such circumstances, recently there have been suggestions of wood flooring that contains emulsified natural essential oils in the adhesive layer between the ornamental veneer and the plywood.

However, in the said wood flooring, the natural essential oils are first evaporated into the air after passing through the adhesive layer, the ornamental veneer, and the paint. Consequently, it has the following drawback: In the case of either wood flooring with surface-adhered wood ornamental veneer that has been impregnated with and strengthened by a synthetic resin or wood flooring with a surface that has been coated thickly with a polyester paint, for example, the natural essential oils cannot pass through the surface layer, so the effect of the natural essential oils is unobtainable.

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[1] Translator's note: Nonstandard term. Intended meaning uncertain. Here and hereinafter, the literal translation (forest bath) is used.

[2] Translator's note: "dani" means both "tick" and "mite." In this patent, "tick" is used.

[3] Translator's note: This word also could be translated as "vermicide."

- **Problems that the Invention is to Solve**

As the result of repeated diligent research in order to overcome the said drawbacks, the inventors, and others, arrived at this invention after the following discoveries: The inventors observed that ① the natural essential oils essentially are materials that do not volatilize readily, so the odor persists for a long time; ② in particular, high-boiling-point constituents such as the cinnamic aldehyde, coumarin, and citronellal (hereinafter, cinnamic aldehyde, etc.), which are contained in wood, have superior gradual release[4], so they are very effective repellents of vermin such as ticks and cockroaches; and ③ the natural essential oils and their high-boiling-point constituents are highly compatible with the thinner used in paint, etc. By mixing a high-boiling-point constituent (e.g., cinnamic aldehyde) into a natural essential oil, they included it in paint, after which they applied this to the surface of wood flooring. In this manner, they were able to add, easily and for an extended period, the so-called forest bath effect and the vermin repellent effect, to any type of wood flooring.

Consequently, the primary purpose of this invention is to provide wood flooring that can exhibit, for an extended period, the forest bath effect and the vermin repellent effect, regardless of the type of wood flooring material.

The secondary purpose of this invention is to provide a method for manufacturing wood flooring with the forest bath effect and the vermin repellent effect, etc., which can be applied to any type of wood flooring.

The tertiary purpose of this invention is to provide a method for manufacturing wood flooring with superior vermin repellent effect in particular, in addition to the forest bath effect.

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[4] Translator's note: Nonstandard term. Here and following, "johosei" is translated literally (gradual release).

- **Means of Solving the Problems**

The aforementioned purposes of this invention were achieved by means of wood flooring and its manufacturing method, characterized in that, in wood flooring with a painted surface, the said paint contains at least one high-boiling-point constituent selected from among cinnamic aldehyde, coumarin, and citronellal as well as a natural essential oil, the main constituent of which is either a terpene or a sesquiterpene.

This invention's natural essential oil-containing wood flooring and its manufacturing method will now be discussed in detail.

The natural essential oil used in this invention can be selected appropriately from commonly known raw materials that contain, as their main constituent, a sequiterpene or a terpene, such as white-cedar leaf oil, white-cedar wood oil, China-grown fir, USSR-grown fir, eucalyptus, Japanese cedar, white-cedar leaf, lemon, orange, lavender, etc. However, to assure the long-term effectiveness of the natural essential oil, it is preferable to use a natural essential oil such as white-cedar leaf oil, white-cedar wood oil, China-grown fir, USSR-grown fir, eucalyptus, Japanese cedar, white-cedar leaf, lavender, etc.

In addition to the said natural essential oil, this invention uses at least one high-boiling-point constituent selected from among cinnamic aldehyde, coumarin, and citronellal. The cinnamic aldehyde, coumarin, citronellal, etc., used as the high-boiling-point constituent in this invention is a wood extract constituent with a superior vermin repellent effect. By adding this, etc., the vermin repellent effect can be maintained for a very long time.

Here, the biological effectiveness decreases when 10 parts or fewer[5] by weight of cinnamic aldehyde, etc., are assumed per 100 parts by weight of natural essential oil, which contains a terpene or a sesquiterpene as the main constituent. Conversely, when more than 10 parts by weight are assumed, the atmospheric concentration and the biological effectiveness increase, but the odor becomes stronger and thus a drawback. Consequently, considering the odor, gradual release, and biological effectiveness, it is preferable to maintain a 100:10-15 (by weight) mixture ratio for the said natural essential oil and the cinnamic aldehyde, etc., which is the high-boiling-point constituent.

In this invention, the said natural essential oil and a high-boiling-point constituent (e.g., cinnamic aldehyde) are diluted to a concentration of 50% by means of a diluent (e.g., ethyl acetate), after which they are mixed with paint thinner.

Next, the said dilute solution is added to the paint base, and the paint viscosity is controlled by also adding a hardening agent and a thinner. Only a small amount of the said dilute solution is required: 1-2 parts by weight per 100 parts by weight paint base.

The wood flooring of this invention is obtained by applying the paint obtained thus to the surface of the wood flooring.

Although three coats are applied normally, the paint used in this invention does not differ from ordinary paint, so it can be applied by means of the normal method. By applying alternate coatings of ordinary paint, as necessary, it is also possible to vary the gradual release to the atmosphere and the biological effect, etc., of the cinnamic aldehyde, etc.

Of course, the paint obtained by means of the manufacturing method of this invention also can be used for purposes other than wood flooring (e.g., interior wall materials and furniture).

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[5] Translator's note: Range boundaries are ambiguous in Japanese, so "10 parts or fewer" could also be "fewer than 10 parts."

- **Effects of the Invention**

As described in detail previously, the wood flooring manufacturing method of this invention is applicable to any type of wood flooring, so it is in no way limited by the materials used.

Also, the wood flooring manufactured according to the method of this invention contains at least one high-boiling-point constituent selected from among cinnamic aldehyde, coumarin, and citronellal, in addition to the natural essential oil which contains a terpene, sesquiterpene, etc., as the principal constituent, so it displays a particularly superior vermin repellent effect as well as the forest bath effect. These effects were maintainable for an extended period.

- **Example 1**

A mixed solution of 100 parts by weight unsaturated polyester resin and 1 part by weight polymerization initiator was injected, by depressurizing and pressurizing in an impregnation oven, into an absolutely dry (water content: 0-3%) 0.5-mm slice of *hinoki* cypress veneer, thereby yielding a resin-impregnated veneer. A hot press was used to thermally compress this resin-impregnated veneer onto plywood coated with an aqueous vinyl urethane adhesive (coating amount: 15 g per square *shaku* [6]), for 8 min. at 150 °C and 12 kg/cm^2. The resin-impregnated veneer and the plywood were adhered when the resin within the veneer was polymerized thermally. This yielded plywood with a surface of reinforced veneer impregnated with a synthetic resin.

Next, with an amino paint as the base, a hardening agent and thinner were mixed in the ratio 100:10:X (by weight). An undercoat of 1.9-2.2 g per square *shaku* was applied to the surface of the said resin-reinforced veneer, and this was dried. Then the same paint used for the undercoat was applied as a second coat of 1.5-2.2 g per square *shaku*, and this was dried. The amount of added thinner (X) was controlled with an Iwata-type cup, in order to yield a paint viscosity of 12-15 sec.

Next, the thinner, the *hinoki* essential oil, and the cinnamic aldehyde were mixed in the ratio 50:45:5 (by weight). The paint base, the said natural essential oil mixed solution, a hardening agent, and thinner were mixed in the ratio 100:1:10:Y (by weight), and the top coat was applied at 6.5-7.0 g per square *shaku*. The amount of added thinner (Y) was controlled with an Iwata-type cup, in order to yield a paint viscosity of 12-15 sec.

The wood flooring obtained thus and ordinary wood flooring were used in tests of their biological effect on ticks, mold, and cockroaches.

The biological effect control test methods and results will be discussed next.

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[6] Translator's note: 1 shaku = 0.994 foot

- **Tick Multiplication Control Test**

4×4-cm sections of the wood flooring of this invention and ordinary wood flooring were placed in sterile laboratory dishes (diameter: 9 cm), with their painted surfaces up. On these, about 0.5 g of a medium (powdered feed: rat feed + dry yeast) in which dust-cuticle[7] ticks had been cultured was spread over a 3×3-cm area. There were about 100 ticks in the culture.

The interiors of the laboratory dishes were kept at a humidity of about 86% with a saturated potassium chloride solution, and the temperature was kept at 25-30 °C.

At 1, 9, and 20 days after the start of the test, the number of ticks living in the medium was counted under a stereoscopic microscope in order to determine the tick survival rate for each flooring. The tick survival rate is determined as follows: The tick population after the test starts is divided by the tick population when the test starts, and the result is multiplied by 100. The results are shown in Figure 1. In the figure, the black dots indicate the wood flooring of this invention, while the white dots indicate ordinary wood flooring. (The same applies to Figures 2 and 3.)

[7] Translator's note: Nonstandard term. Intended meaning uncertain. Literally "dust; powder" + "cuticle".

- **Mold Resistance Test**

The test was conducted according to the test method for general industrial products and wood/bamboo products of the Mold Resistance Test Method (JIS Z 2991, 1981).

Five strains (Aspergillus niger (IFO 6341), Penicilium citrinum (IFO 6352), Rhizopus stolonifer (FERM S-7), Cladosporium cladosporioides (IFO 6348), Chaetomium globosum (IFO 6347)) were cultured in a 25-°C atmosphere for 10 days, with a potato dextrose agar slant culture. Monospore suspensions were obtained by suspending spores in a sterile 0.05% aqueous solution of dioctyl sodium sulfosuccinate. Next, a mixed spore suspension was obtained by mixing the spore suspensions in equal amounts.

Test pieces made by preparing 5×5-cm cuttings of the wood flooring of this invention and ordinary wood flooring (2 series conducted for each flooring) were placed in laboratory dishes. From above, the said mixed-spore suspension was sprinkled uniformly at the rate of 0.5 ml per 9 cm^2 of showing surface area, after which the dishes were covered and cultured at about 97% humidity and 28 ± 2 °C. After they were cultured for 14 and 28 days, the development state of the hyphae that resulted on the fronts and the sides of the test pieces was observed with the naked eye.

The test results are shown in Table 1.

Table 1

Test Sample	After 14 days of cultivation		After 28 days of cultivation	
	Front	Side	Front	Side
A) ①	3	3	3	3
②	3	3	3	3
B) ①	2	2	1	1
②	2	2	1	1

+ Test
- control

In the table, A) are the wood flooring of this invention, and B) are ordinary wood flooring. (The same applies to Tables 2-6.) Furthermore, the numbers in the tables indicate the following values. (The same applies to Tables 3 and 5.)

3: Hyphae development was not apparent in inoculated areas of the test pieces or samples.

2: The area of hyphae development observed in inoculated areas of the test pieces and samples did not exceed 1/3 of the total area.

1: The area of hyphae development observed in inoculated areas of the test pieces and samples exceeded 1/3 of the total area.

- **Cockroach Repellent Effectiveness Test**

A plywood box measuring 30 × 60 × 30 (H/W/D) was manufactured, and the center of the resulting box was partitioned with plywood. Holes that allowed the cockroaches (black cockroaches) to pass through were made in a part of the bottom. The wood flooring of this invention and common wood ornamental veneer flooring (each 30 × 30 cm) were placed at the bottom of the left and right partitioned spaces. The same number of cockroaches (about 10 each) were turned loose on each flooring. The spaces were covered with a plywood lid, and this was maintained in a 25-30 °C atmosphere. After 24 hours, the lid was removed, and the number of cockroaches on each flooring was counted. This test was repeated three times. A new box and flooring were used for each test, in order to avoid the effect of the residual odor of the cockroaches and the natural essential oils. Furthermore, the formalin remaining in the plywood was removed with a formalin catcher agent. The cockroach survival rate was determined from the number of cockroaches present on the floorings 24 hours after the start of the test. The results are shown in Table 2.

The cockroach survival rate is computed by dividing the cockroach population on each flooring by the total test cockroach population, and then multiplying the result by 100.

Table 2

Test Subjects	1×	2×	3×	Total
A) Population (no.)	1	0	1	2
Survival rate (%)	6	0	5	3
B) Population (no.)	19	20	19	58
Survival rate (%)	95	100	95	97

These results prove that the wood flooring of this invention is effective against ticks, mold, and cockroaches. This effectiveness is assumed to be attributable mainly to the high-boiling-point constituent (e.g., cinnamic aldehyde). This confirms that a high biological effectiveness is obtained by the addition, to paint, of just a little cinnamic aldehyde, etc.

- **Example 2**

Except that citronellal was used, the wood flooring was manufactured as in Example 1. As in Example 1, the biological effects on ticks, mold, and cockroaches were tested.

Figure 2 shown the results of the tick multiplication control test. Table 3 lists the results of the mold resistance test. Table 4 contains the results of the cockroach repellent effectiveness test.

Table 3

Test Piece	After 14 days of cultivation		After 28 days of cultivation	
	Front	Side	Front	Side
A) ①	3	3	3	3
②	3	3	3	3
B) ①	2	1	1	1
②	2	2	1	1

Table 4

Test Subjects	1×	2×	3×	Total
A) Population (no.)	2	2	0	5
Survival rate (%)	10	15	0	8
B) Population (no.)	18	17	20	55
Survival rate (%)	90	85	100	92

- **Comparative Example 1**

Only *hinoki* essential oil was used. Cinnamic aldehyde was not added. Otherwise, wood flooring was manufactured according to the manufacturing process Example 1. The biological effect test of Example 1 was performed, and the results were compared with the test that included added cinnamic aldehyde.

Figure 3 shown the results of the tick multiplication control test. Table 5 lists the results of the mold resistance test. Table 6 contains the results of the cockroach repellent effectiveness test.

Table 5

Test Piece	After 14 days of cultivation		After 28 days of cultivation	
	Front	Side	Front	Side
A) ①	3	3	2	2
②	3	3	3	3
B) ①	2	2	1	1
②	2	2	1	1

Table 6

Test Subjects	1×	2×	3×	Total
A) Population (no.)	5	5	7	17
Survival rate (%)	10	25	35	28
B) Population (no.)	15	15	13	43
Survival rate (%)	75	75	65	72

These results prove the following: Although a hygienic biological effect occurs even when the flooring contains only natural essential oils that contain terpenes or sesquiterpenes as their main constituent, the vermin repellent effect of wood flooring that also contains a high-boiling-point constituent (e.g., cinnamic aldehyde) is markedly superior.

- **Example 3**

Assuming that the wood flooring of this invention obtained in Example 1 was provided for an 8-*tatami*-mat room, the wood flooring of this invention was placed, in the proportion of an 8-*tatami*-mat room, at the bottom of a test box, which had a volume equal to 1/1000 that of an 8-*tatami*-mat room. Then estimates were made by measuring the atmospheric concentration within the box.

The atmospheric concentration measurements were made as follows: While the wood flooring of this invention was left in the said box for a specified time, a vacuum pump was mounted on a Tenax[8] GC tube, and the interior air was sucked out for a specified time. The filler-adsorbed components were analyzed quantitatively with the GC-MS. From the ratios of these adsorbed components and the amount of air removed by the vacuum pump, the atmospheric concentrations of the high-boiling-point constituents and the terpenes or sequiterpenes were computed.

By means of this measurement method, the atmospheric concentration for the used wood flooring of this invention was determined to be 5-6 ppb (1 ppm / 1000), immediately after manufacture. Also, one year after manufacture, the atmospheric concentration for the used wood flooring was about 1 ppb.

These measurement results prove that, although the atmospheric concentration decreases over time, the gradual release is maintained.

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[8] Translator's note: Nonstandard term. Intended meaning uncertain. Possibly a brand name. Literally, "tennakusu."

- **Example 4**

Using the flooring of this invention obtained in Example 1, 20-person olfactory sense tests were performed for the surfaces of the wood flooring of this invention, immediately after manufacture, 1 year after manufacture, and 2 years after manufacture. Although the results differed somewhat according to the tester, they were generally as follows:

Immediately after manufacture:	smell	→	strong
One year after manufacture:	smell	→	weak but detectable
Two years after manufacture:	smell	→	slightly detectable

From these results, it is inferred that the gradual release is maintained sufficiently for on the order of several years.

4. Brief Explanation of the Drawings

Figure 1 shows the results of the tick multiplication control test of Example 1.

Figure 2 shows the results of the tick multiplication control test of Example 2.

Figure 3 shows the results of the tick multiplication control test of Comparative Example 1.

In the figures, black dots indicate the wood flooring of this invention, and white dots indicate general wood flooring.

Key to Figures 1-3

1 Figure 1

2 Figure 2

3 Figure 3

4 Tick survival rate (%)

5 Survival days (days)

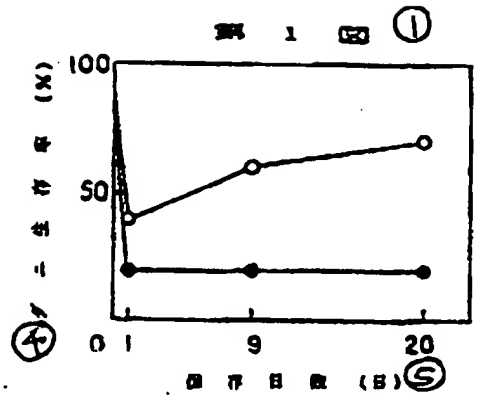

Figure 1

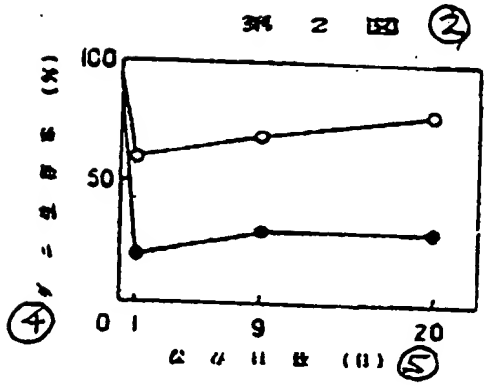

Figure 2

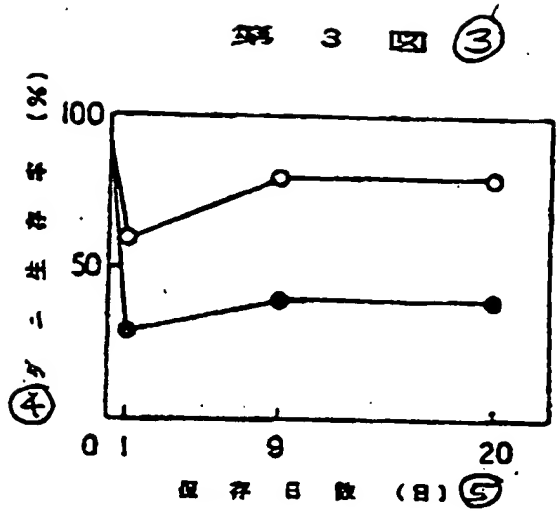

Figure 3